

DECLARATION OF DR. RANDELL L. MILLS

I, Randell L. Mills, declare and state as follows:

1. I am the founder and CEO of BlackLight Power, Inc., located at 493 Old Trenton Road, Cranbury, New Jersey 08512.
2. I majored in chemistry and received my bachelor of arts degree, *summa cum laude* and Phi Beta Kappa, from Franklin & Marshall College in 1982. I received a medical degree from Harvard Medical School in 1986. While attending Harvard Medical School, I concurrently spent a year taking courses in advanced electrical engineering at the Massachusetts Institute of Technology. I have also had significant academic training in biology, chemistry, mathematics and physics.
3. I began my research in the field of energy technology over ten years ago. I have authored, co-authored or collaborated on numerous publications, reports and presentations at scientific meetings in the field of energy technology and novel hydrogen chemistry, as shown in the attachment hereto.
4. I am fully qualified to conduct the research that led to the discovery and development of BlackLight's lower-energy hydrogen technology.
5. I personally conducted and/or supervised the experimental data disclosed in the articles submitted to the U.S. Patent and Trademark Office ("PTO"), which are described in the following Paragraph Nos. 6 through 15. The coauthors, if any, assisted me in preparing the data.
6. **R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach," J. Phys. D., submitted. (Web Publication Date: Aug. 6, 2003.)**

It is taught that the chemical bond exists due to a phenomenon that is unique to quantum mechanics. Specifically, the nature of the chemical bond is based on a nonphysical "exchange integral" that is a consequence of a postulated linear combination of product wavefunctions wherein it is implicit that each point electron with infinite self-electric-and-magnetic-field energies must exist as a "probability-wave cloud" and be in two places at the same time (i.e. centered on two nuclei simultaneously!) A further nonphysical aspect is that the molecular solution is obtained without considering the nuclei to move under the Born-Oppenheimer approximation; yet, the molecule must have a further nonphysical perpetual-motion-type property of "zero-point vibration." Additional internal inconsistencies arise. The electron clouds mutually shield the nuclear charge to provide an adjustable parameter, "effective nuclear charge"; yet, neither has any self shielding effect even

though the clouds are mutually indistinguishable and must classically result in a self interaction force equivalent to 1/2 the central attractive force. Furthermore, the hydrogen molecule is electron-spin paired. The magnitude of the corresponding force between the point electrons is equivalent to the electric force as the separation goes to zero. This term as well as the self-interaction term are conspicuously absent from the Hamiltonian. Instead arbitrary types of variational parameters of the wavefunctions and mixing of wavefunctions as well as other adjustable parameters such as the effective nuclear charge, ionic character, and correlation interactions are introduced to force the solutions of a multitude of methods such as valence bond, valence bond plus ionic terms, molecular orbital theory, molecular-orbital with configuration interaction, self consistent field method, SCF-LCAO-MO, Hartree-Fock, Slater orbitals, ionic terms, valence-shell electron-pair-repulsion (VSEPR) method, etc. to more closely approximate the experimental parameters. Yet, the experimental bond energy is not calculated; rather a parameter D_e is determined from which the "zero-point vibration" is subtracted and "anharmonicity term in the zero-point vibration" is added to obtain the experimentally measurable bond energy D_0 . Zero-point vibration has never been directly measured, it violates the second law of thermodynamics, and it is in conflict with direct experimental results such as the formation of solid hydrogen and Bose-Einstein condensates of molecules. As a consequence, the bond energy predictions of quantum mechanics have never been tested experimentally, and it is not possible to state that the methods predict the experimental bond energy at all. The many conflicting attempts suffer from the same short comings that plague atomic quantum theory, infinities, instability with respect to radiation according to Maxwell's equations, violation of conservation of linear and angular momentum, lack of physical relativistic invariance, etc. From a physical perspective, the implication for the basis of the chemical bond according to quantum mechanics being the exchange integral and the requirement of zero-point vibration, "strictly quantum mechanical phenomena", is that the theory can not be a correct description of reality. A proposed solution based on physical laws and fully compliant with Maxwell's equations solves the parameters of molecular ions and molecules of hydrogen isotopes in closed form equations with fundamental constants only. The agreement is remarkable. A physical basis for density functional theory may exist.

7. R. L. Mills, P. Ray, M. Nansteel, J. He, X. Chen, A. Voigt, B. Dhandapani, "Energetic Catalyst-Hydrogen Plasma Reaction Forms a New State of Hydrogen," in preparation.

Plasmas of certain catalysts such as Sr^+ , Ar^+ , Ne^+ , and He^+ mixed with hydrogen were studied for evidence of a novel energetic reaction. A hydrogen plasma was observed to form at low temperatures (e.g. $\approx 10^3 K$) and an extraordinary low field strength of about 1-2 V/cm when argon and strontium were present with atomic hydrogen. RF and microwave plasmas were used to generate He^+ , Ne^+ , and Ar^+ catalysts. Extraordinarily fast H (40-50 eV) was observed by Balmer α line broadening only from plasmas having a catalyst with H. Novel extreme ultraviolet (EUV) emission lines were observed that corresponded to a Rydberg

series of H corresponding to fractional principal quantum numbers wherein $n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}$; ($p \leq 137$ is an integer) replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states. Corresponding emission due to fraction-principal-quantum-level hydrogen molecular ion $H_2^+(1/p)$ and molecular hydrogen $H_2(1/p)$ were also observed. $H_2(1/p)$ gas was isolated by liquefaction using an high-vacuum (10^{-6} Torr) capable, liquid nitrogen cryotrap and was characterized by mass spectroscopy (MS), EUV optical emission spectroscopy (EUV OES), and 1H NMR of the condensable gas dissolved in $CDCl_3$. The condensable gas was highly pure mass two by MS. A unique EUV emission spectrum was observed by OES. The observation that the novel EUV emission spectrum shifted with deuterium substitution in a region where no hydrogen emission has ever been observed strongly supported the existence of lower-energy molecular hydrogen. Contaminants and exotic helium-hydrogen species were eliminated as the source of the reaction and condensed gas plasma emission spectra. Upfield shifted NMR peaks were observed at 2.18 and 3.47 ppm compared to that of H_2 at 4.63 ppm. Excess power was absolutely measured from the helium-hydrogen plasma. For an input of 41.9 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 62.1 W corresponding to 20.2 W of excess power in 3 cm^3 . The excess power density and energy balance were high, 6.7 W/cm^3 and $-5.4 \times 10^4 \text{ kJ/mole } H_2$ (280 eV/H atom), respectively.

8. R. L. Mills, P. Ray, M. Nansteel, J. He, X. Chen, A. Voigt, B. Dhandapani, Luca Gamberale, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source", *European Physical Journal D*, submitted. (Web Publication Date: June 6, 2003.)

Plasmas of certain catalysts such as Sr^+ , Ar^+ , Ne^+ , and He^+ mixed with hydrogen were studied for evidence of a novel energetic reaction. A hydrogen plasma was observed to form at low temperatures (e.g. $\approx 10^3 \text{ K}$) and an extraordinary low field strength of about 1-2 V/cm when argon and strontium were present with atomic hydrogen. RF and microwave plasmas were used to generate He^+ , Ne^+ , and Ar^+ catalysts. Extraordinarily fast H (40-50 eV) was observed by Balmer α line broadening only from plasmas having a catalyst with H. Novel extreme ultraviolet (EUV) emission lines were observed that corresponded to a Rydberg series of H corresponding to fractional principal quantum numbers wherein $n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}$; ($p \leq 137$ is an integer) replaces the well known parameter $n = \text{integer}$ in the Rydberg equation for hydrogen excited states. Corresponding emission due to fraction-principal-quantum-level hydrogen molecular ion $H_2^+(1/p)$ and molecular hydrogen $H_2(1/p)$ were also observed. $H_2(1/p)$ gas was isolated by liquefaction using an high-vacuum (10^{-6} Torr) capable, liquid nitrogen cryotrap and was characterized by gas chromatography (GC), mass spectroscopy (MS), visible and EUV optical emission spectroscopy (OES), and 1H NMR of the condensable gas dissolved in $CDCl_3$. Novel peaks were observed by cryogenic gas chromatography performed on the condensable gas which was highly pure hydrogen by MS and had a higher ionization energy

than H_2 . A unique EUV emission spectrum was observed by OES. The observation that the novel EUV emission spectrum shifted with deuterium substitution in a region where no hydrogen emission has ever been observed strongly supported the existence of lower-energy molecular hydrogen. Contaminants and exotic helium-hydrogen species were eliminated as the source of the reaction and condensed gas plasma emission spectra. Upfield shifted NMR peaks were observed at 3.22, 3.25, and 3.47 ppm compared to that of H_2 at 4.63 ppm. Excess power was absolutely measured from the helium-hydrogen plasma. For an input of 44.3 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 62.9 W corresponding to 18.6 W of excess power in 3 cm^3 . The excess power density and energy balance were high, 6.2 W/cm^3 and $-5 \times 10^4\text{ kJ/mole } H_2$ (240 eV/H atom), respectively.

9. R. Mills, P. Ray, "New H I Laser Medium Based on Novel Energetic Plasma of Atomic Hydrogen and Certain Group I Catalysts", J. Plasma Physics, submitted.

Rb^+ to Rb^{2+} and $2K^+$ to $K + K^{2+}$ each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. The presence of these gaseous ions with thermally dissociated hydrogen formed a plasma having strong VUV emission with a stationary inverted Lyman population. Significant Balmer α line broadening of 18 and 12 eV was observed from a rt-plasma of hydrogen with KNO_3 , and $RbNO_3$, respectively, compared to 3 eV from a hydrogen microwave plasma. We propose an energetic catalytic reaction involving a resonant energy transfer between hydrogen atoms and Rb^+ or $2K^+$ to form a very stable novel hydride ion. Its predicted binding energy of 3.0468 eV with the fine structure was observed at 4071 \AA , and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563\text{ eV}$ (j is an integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^4 . Characteristic emission from each catalyst was observed. This catalytic reaction may pump a cw HI laser.

10. R. L. Mills, P. Ray, M. Nansteel, J. He, X. Chen, A. Voigt, B. Dhandapani, "Characterization of Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source", Am. Chem. Soc. Div. Fuel Chem. Prepr., Vol. 48, No. 2, (2003).

The possibility that a novel reaction of atomic hydrogen that uses certain catalysts such as He^+ , oxygen, and Group I atoms or ions may be a clean new energy source is supported by spectroscopic, chemical, and thermal data. For example, we report the discovery of new states of hydrogen formed in a catalytic plasmas reaction. The states were identified by the spectroscopic observation of emission lines occurring at energies that are an extension of the Rydberg series to lower states. The novel molecular hydrogen gas product was isolated by liquefaction at liquid nitrogen temperature, and was identified by the observations of novel peaks by cryogenic gas chromatography, a higher ionization energy than H_2 by mass spectroscopy, a unique EUV emission spectrum by optical emission spectroscopy that shifted with deuterium substitution in a region where no hydrogen emission has ever been observed, and upfield shifted NMR peaks at 3.22 and 3.47

ppm compared to that of H_2 at 4.63 ppm. In addition, stationary H populations were formed by using certain catalysts in hydrogen plasmas, and novel processes and hydride products with significant commercial potential were characterized by EUV and visible spectroscopy, NMR, ToF-SIMS, and XPS. Very high (>100 eV) H energies and substantial excess thermal energy were observed.

11. R. Mills, P. C. Ray, R. M. Mayo, M. Nansteel, W. Good, P. Jansson, B. Dhandapani, J. He, "Hydrogen Plasmas Generated Using Certain Group I Catalysts Show Stationary Inverted Lyman Populations and Free-Free and Bound-Free Emission of Lower-Energy State Hydride", Technical Physics, submitted.

Rb^+ to Rb^{2+} and $2K^+$ to $K + K^{2+}$ each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. The presence of these gaseous ions with thermally dissociated hydrogen formed a plasma having strong VUV emission with a stationary inverted Lyman population. Significant Balmer α line broadening of 18 and 12 eV was observed from a rt-plasma of hydrogen with KNO_3 , and $RbNO_3$, respectively, compared to 3 eV from a hydrogen microwave plasma. The reaction was exothermic since excess power of about 20 mW/cc was measured by Calvet calorimetry. We propose an energetic catalytic reaction involving a resonance energy transfer between hydrogen atoms and Rb^+ or $2K^+$ to form a very stable novel hydride ion. Its predicted binding energy of 3.0468 eV with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563$ eV (j is an integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^4 . Characteristic emission from each catalyst was observed. This catalytic reaction may pump a cw HI laser.

12. R. Mills, J. Sankar, A. Voigt, J. He, P. Ray, B. Dhandapani, "Role of Atomic Hydrogen Density and Energy in Low Power CVD Synthesis of Diamond Films", JACS, in preparation.

Polycrystalline diamond films were synthesized on silicon substrates without diamond seeding by a very low power (~40-80 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%) or argon-hydrogen-methane (17.5/80/2.5%). But, only diamond-like carbon (DLC) films or no films formed when neon, krypton, or xenon was substituted for helium or argon. The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, scanning electron microscopy (SEM), and X-ray diffraction (XRD). It is proposed that each of He^+ and Ar^+ served as a catalyst with atomic hydrogen to form an energetic plasma since only plasmas having these ions in the presence of atomic hydrogen showed significantly broadened H α lines corresponding to an average hydrogen atom temperature of >100 eV as reported previously [R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer α Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, (2002), Vol. 92, No. 12, pp. 7008-7022]. It was found that not only the energy, but also the H density

uniquely increases in $He-H_2$ and $Ar-H_2$ plasmas. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

13. R. Mills, B. Dhandapani, M. Nansteel, J. He, P. Ray, "Liquid-Nitrogen-Condensable Molecular Hydrogen Gas Isolated from a Catalytic Plasma Reaction", J. Phys. Chem. B, submitted.

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6 \text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, 11$ or these discrete energies less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen, formed by a resonant nonradiative energy transfer to He^+ . Corresponding emission due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at $E_{D+vib} = p^2 E_{D H_2} \pm \left(\frac{v^*}{3}\right) E_{vib H_2(v=0 \rightarrow v=1)}$, $v^* = 1, 2, 3, \dots$ was observed at the longer wavelengths for $v^* = 2$ to $v^* = 32$ and at the shorter wavelengths for $v^* = 1$ to $v^* = 16$ where $E_{D H_2}$ and $E_{vib H_2(v=0 \rightarrow v=1)}$ are the experimental bond and vibrational energies of H_2 , respectively. Fraction-principal-quantum-level molecular hydrogen $H_2(1/p)$ gas was isolated by liquefaction using an high-vacuum (10^{-6} torr) capable, liquid nitrogen cryotrap and was characterized by gas chromatography (GC), mass spectroscopy (MS), visible and EUV optical emission spectroscopy (OES), and 1H NMR of the condensable gas dissolved in $CDCl_3$. Novel peaks were observed by cryogenic gas chromatography performed on the condensable gas which was highly pure hydrogen by MS and had a higher ionization energy than H_2 . A unique EUV emission spectrum was observed by OES. The observation that the novel EUV emission spectrum shifted with deuterium substitution in a region where no hydrogen emission has ever been observed unequivocally confirmed the existence of lower-energy molecular hydrogen. Contaminants and exotic helium-hydrogen species were eliminated as the source of the reaction and condensed gas plasma emission spectra. Upfield shifted NMR peaks were observed at 3.22 and 3.47 ppm compared to that of H_2 at 4.63 ppm.

14. R. L. Mills, P. Ray, J. He, B. Dhandapani, M. Nansteel, "Novel Spectral Series from Helium-Hydrogen Evenson Microwave Cavity Plasmas that Matched Fractional-Principal-Quantum-Energy-Level Atomic and Molecular Hydrogen", European Journal of Physics, submitted. (Web Publication Date: April 24, 2003.)

Extreme ul recorded on 85 W Evenson microwave cavity discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6 \text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, 11$ or these

discrete energies less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of $\text{He}(1s^2)$ to $\text{He}(1s^1 2p^1)$. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen, formed by a resonant nonradiative energy transfer to He^+ . Corresponding emission due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at $E_{D+vib} = p^2 E_{D H_2} \pm \left(\frac{v^*}{3}\right) E_{vib H_2(v=0 \rightarrow v=1)}$, $v^* = 1, 2, 3, \dots$ was observed at the longer wavelengths for $v^* = 2$ to $v^* = 32$ and at the shorter wavelengths for $v^* = 1$ to $v^* = 16$ where $E_{D H_2}$ and $E_{vib H_2(v=0 \rightarrow v=1)}$ are the experimental bond and vibrational energies of H_2 , respectively. Replacement of hydrogen with deuterium eliminates the resonance condition for emission, and none of the peaks of the $E_{D+vib} = 17.913 \pm \left(\frac{v^*}{3}\right) 0.515902 \text{ eV}$ series observed in the hydrogen mixed plasmas were observed with deuterium substitution. The Evenson cavity was scaled-up to operate at 600 W input power, and an additional intense peak was observed at 41.6 nm . This peak with an energy of 29.81 eV matched $q \cdot 13.6 \text{ eV}$ with $q = 4$ less 24.58741 eV corresponding to inelastic scattering of these photons by helium atoms due to ionization of He to He^+ .

15. R. L. Mills, P. Ray, R. M. Mayo, Highly Pumped Inverted Balmer and Lyman Populations, New Journal of Physics, submitted.

Comprehensive Studies on our recent brief publication [R. Mills, P. Ray and R. M. Mayo, "The Potential for a Hydrogen Water-Plasma-Laser", Applied Physics Letters, Vol. 82, No. 11, 2003, pp. 1679-1681] on the potential of realizing a CW H I laser based on a water vapor plasma are presented. Stationary inverted H Balmer and Lyman populations were observed from a low pressure water-vapor microwave discharge plasma. The ionization and population of excited atomic hydrogen levels was attributed to energy provided by a catalytic resonant energy transfer between hydrogen atoms and molecular oxygen formed in the water plasma. The catalysis mechanism was supported by the observation of O^{2+} and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone. The high hydrogen atom temperature with a relatively low electron temperature, $T_e = 2 \text{ eV}$, exhibited characteristics of cold recombining plasmas. These conditions of a water plasma favored an inverted population in the lower levels. Thus, the catalysis of atomic hydrogen may pump a cw H I laser. From our results, laser oscillations are may be possible from (i) $n = 3, n = 4, n = 5, n = 6, n = 7$, and $n = 8$ to $n = 2$, (ii) $n = 4, n = 5, n = 6$, and $n = 7$ to $n = 3$, and (iii) $n = 5$, and $n = 6$ to $n = 4$. Lines of the Balmer series of $n = 5$, and $n = 6$ to $n = 2$ and the Paschen series of $n = 5$ to $n = 3$ were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. At an average microwave input power of $9 \text{ W} \cdot \text{cm}^{-3}$, a collisional radiative model showed that the hydrogen excited state population distribution was consistent with an $n = 1 \rightarrow 5, 6$ pumping power of an unprecedented $200 \text{ W} \cdot \text{cm}^{-3}$. Back illumination with an infrared source showed depopulation of the $n = 5$ state. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which

may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new atomic gas laser in over a decade, and it may prove to be the most efficient, versatile, and useful of all. A further application is the direct generation of electrical power using photovoltaic conversion of the spontaneous or stimulated water vapor plasma emission.

16. R. L. Mills, P. Ray, J. Dong, M. Nansteel, R. M. Mayo, B. Dhandapani, X. Chen, "Comparison of Balmer α Line Broadening and Power Balances of Helium-Hydrogen Plasma Sources", *Plasma Sources Science and Technology*, submitted. (Web Publication Date: March 12, 2003.)

From the width of the 656.3 nm Balmer α line emitted from glow discharge, Evenson microwave, MKS/Astex microwave, and inductively coupled RF plasmas, it was found that Evenson cavity microwave helium-hydrogen plasmas showed significant broadening corresponding to an average hydrogen atom energy of 180-210 eV with only a fast population. Inductively coupled RF helium-hydrogen plasmas showed extraordinary broadening corresponding to an average hydrogen atom energy of 250-310 eV, but the fast population was a minor component compared to the slow of ≈ 35 eV. The corresponding results from the glow discharge plasmas were 33-38 eV and 30-35 eV, respectively, compared to ≈ 4 eV for plasmas of pure hydrogen and xenon-hydrogen maintained in any of the sources and helium-hydrogen plasmas maintained in the MKS/Astex microwave system. Stark broadening or acceleration of charged species due to high electric fields can not explain the microwave and inductively coupled RF results since the electron density was low and no high field was present. Rather, a resonant energy transfer mechanism is proposed, and the corresponding exothermic reaction was confirmed by power balance measurements. With an input of 24.8 ± 1 W, the total plasma power of the Evenson microwave helium-hydrogen plasma measured by water bath calorimetry was 49.1 ± 1 W corresponding to 24.3 ± 1 W of excess power in 3 cm^3 . The excess power density and energy balance were high, 8.1 W/cm^3 and over $-3 \times 10^4 \text{ kJ/mole H}_2$, respectively. With an input of 500 W, a total power of 623 W was generated in a 45 cm^3 compound-hollow-cathode-glow discharge. Less than 10% excess power was observed from inductively coupled RF helium-hydrogen plasmas. No measurable heat was observed from MKS/Astex microwave helium-hydrogen plasmas.

17. R. Mills, P. Ray, M. Nansteel, R. M. Mayo, "Comparison of Water-Plasma Sources of Stationary Inverted Balmer and Lyman Populations for a CW HI Laser", *J. Appl. Spectroscopy*, in preparation.

Stationary inverted H Balmer and Lyman populations were observed from a low pressure water-vapor Evenson microwave discharge plasma, but not from glow discharge, RF, and microwave plasmas maintained in several other microwave cavity types. The ionization and population of excited atomic hydrogen levels in the plasma maintained in the Evenson cavity was attributed to energy provided by a catalytic resonant energy transfer between hydrogen atoms and molecular oxygen formed in the water plasma. The catalysis mechanism was supported by the observation of O^{2+} and H Balmer line broadening of 55 eV compared to 1 eV for

hydrogen alone. The high hydrogen atom temperature with a relatively low electron temperature, $T_e = 2 \text{ eV}$, exhibited characteristics of cold recombining plasmas. These conditions of a water plasma favored an inverted population in the lower levels. Thus, the catalysis of atomic hydrogen may pump a cw HI laser. From our results, laser oscillations are may be possible from i) $n = 3, n = 4, n = 5, n = 6, n = 7$ and $n = 8$ to $n = 2$, ii) $n = 4, n = 5, n = 6$, and $n = 7$ to $n = 3$ and iii) $n = 5$ and $n = 6$ to $n = 4$. Lines of the Balmer series of $n = 5$, and $n = 6$ to $n = 2$ and the Paschen series of $n = 5$ to $n = 3$ were of particular importance because of the potential to design blue and 1.3 micron infrared lasers, respectively, which are ideal for many communications and microelectronics applications. At a microwave input power of $9 \text{ W} \cdot \text{cm}^{-3}$, a collisional radiative model showed that the hydrogen excited state population distribution was consistent with an $n = 1 \rightarrow 5, 6$ pumping power of an unprecedented $200 \text{ W} \cdot \text{cm}^{-3}$. High power hydrogen gas lasers are anticipated at wavelengths, over a broad spectral range from far infrared to violet which may be miniaturized to micron dimensions. Such a hydrogen laser represents the first new atomic gas laser in over a decade, and it may prove to be the most efficient, versatile, and useful of all. A further application is the direct generation of electrical power using photovoltaic conversion of the spontaneous or stimulated water vapor plasma emission.

18. R. Mills, J. Sankar, A. Voigt, J. He, P. Ray, B. Dhandapani, "Synthesis and Characterization of Diamond Films from MPCVD of an Energetic Argon-Hydrogen Plasma and Methane", *Materials Science*, submitted. (Web Publication Date: May 7, 2003.)

Polycrystalline diamond films were synthesized on silicon substrates by a low power ($\sim 80 \text{ W}$) microwave plasma chemical vapor deposition (MPCVD) reaction of a mixture of argon-hydrogen-methane (17.5/80/2.5%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, scanning electron microscopy (SEM), and X-ray diffraction (XRD). It is proposed that Ar^+ served as a catalyst with atomic hydrogen to form an energetic plasma. CH , C_2 , and C_3 emissions were observed with significantly broadened H α line. The average hydrogen atom temperature of a argon-hydrogen-methane plasma was measured to be $110 - 130 \text{ eV}$ versus $\approx 3 \text{ eV}$ for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

19. R. Mills, P. Ray, B. Dhandapani, W. Good, P. Jansson, M. Nansteel, J. He, A. Voigt, "Spectroscopic and NMR Identification of Novel Hydride Ions in Fractional Quantum Energy States Formed by an Exothermic Reaction of Atomic Hydrogen with Certain Catalysts", *European Physical Journal-Applied Physics*, submitted. (Web Publication Date: Feb. 21, 2003.)

$2K^+$ to $K + K^{2+}$ and K to K^{3+} provide a reaction with a net enthalpy equal to the one and three times the potential energy of atomic hydrogen, respectively. The presence of these gaseous ions or atoms with thermally dissociated hydrogen formed a so-called resonance transfer (rt) plasma having strong VUV emission with a stationary inverted Lyman population. Significant line broadening of the Balmer α , β , and γ lines of 18 eV was observed, compared to 3 eV from a hydrogen microwave plasma. Emission from rt-plasmas occurred even when the electric field applied to the plasma was zero. The reaction was exothermic since excess power of $20 \text{ mW} \cdot \text{cm}^{-3}$ was measured by Calvet calorimetry. An energetic catalytic reaction was proposed involving a resonant energy transfer between hydrogen atoms and $2K^+$ or K to form very stable novel hydride ions $H^-(1/p)$ called hydrino hydrides having a fractional principal quantum numbers $p = 2$ and $p = 4$, respectively. Characteristic emission was observed from K^{2+} and K^{3+} that confirmed the resonant nonradiative energy transfer of 27.2 eV and $3 \cdot 27.2 \text{ eV}$ from atomic hydrogen to $2K^+$ and K , respectively.

The predicted binding energy of $H^-(1/2)$ of 3.0471 eV with the fine structure was observed at 4071 \AA , and its predicted bound-free hyperfine structure lines $E_{\text{HF}} = j^2 3.00213 \times 10^{-5} + 3.0563 \text{ eV}$ (j is an integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^4 . $H^-(1/4)$ was observed spectroscopically at 110 nm corresponding to its predicted binding energy of 11.2 eV . The ^1H MAS NMR spectrum of novel compound KH^*Cl relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $p = 4$. A novel peak of KH^*I at -1.5 ppm relative to TMS corresponding to an absolute resonance shift of -33.0 ppm matched the theoretical prediction of $p = 2$. The predicted catalyst reactions, position of the upfield-shifted NMR peaks, and spectroscopic data for $H^-(1/2)$ and $H^-(1/4)$ were found to be in agreement.

20. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Foundations Phys., submitted. (Web Publication Date: Jan. 27, 2003.)

An old argument from Feynman [1] based on the Heisenberg Uncertainty Principle (HUP) was recently posted by Krieg [2] in an attempt to show that standard quantum theories (SQM) preclude the existence lower-energy hydrogen states, predicted [3-5] and now reported by Mills et al. [6-9] which represents a possible new hydrogen energy source. Rather than achieving this goal, Feynman's argument is shown to be internally inconsistent and fatally flawed, and Krieg's posting of this argument further brings to light the many inconsistencies and shortcomings of SQM and the intrinsic HUP that have not been resolved from the days of the inception of SQM. Unfortunately these issues are largely ignored by the physics community.

21. R. Mills, J. He, B. Dhandapani, P. Ray, "Comparison of Catalysts and Microwave Plasma Sources of Vibrational Spectral Emission of Fractional-Rydberg-State Hydrogen Molecular Ion", Canadian Journal of Physics, submitted.

Novel emission lines with energies of $q \cdot 13.6 \text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9$, or 11 were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. Mills, P. Ray, Int. J. Hydrogen Energy, Vol. 27, No. 3, pp. 301-322]. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen where p is an integer, formed by a resonant nonradiative energy transfer to He^+ acting as a catalyst. Ne^+ and Ar^+ also serve as catalysts to form $H(1/p)$; whereas, krypton, xenon, and their ions serve as controls. $H(1/p)$ may react with a proton to form a molecular ion $H_2^+(1/p)^+$ that has a bond energy and vibrational levels that are p^2 times those of the molecular ion comprising uncatalyzed atomic hydrogen. Extreme ultraviolet (EUV) spectroscopy was recorded on microwave plasmas of the noble gases mixed with 10% hydrogen in the range 10-65 nm. Emission in this region due to the reaction $H(1/4) + H^+ \rightarrow H_2(1/4)^+$ with vibronic coupling at $E_{D+vib} = 4^2 E_{D H_2^+} \pm \nu^* 2^2 E_{vib H_2^+ (\nu=0 \rightarrow \nu=1)}$, $\nu^* = 0, 1, 2, 3 \dots$ was observed at the longer wavelengths for $\nu^* = 0$ to $\nu^* = 20$ and at the shorter wavelengths for $\nu^* = 0$ to $\nu^* = 3$ where $E_{D H_2^+}$ and $E_{vib H_2^+ (\nu=0 \rightarrow \nu=1)}$ are the experimental bond and vibrational energies of H_2^+ , respectively. The vibrational series was only observed for helium, neon, and argon. In a comparison of Evenson, McCarroll, cylindrical, and Beenakker microwave cavity plasmas, the Evenson cavity consistently gave the highest intensities.

22. R. L. Mills, P. Ray, X. Chen, B. Dhandapani, "Vibrational Spectral Emission of Fractional-Principal-Quantum-Energy-Level Molecular Hydrogen", J. of the Physical Society of Japan, submitted. (Web Publication Date: Sept. 9, 2002.)

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6 \text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, 11$ or these discrete energies less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen, formed by a resonant nonradiative energy transfer to He^+ as recently reported [R. L. Mills, P. Ray, B. Dhandapani, J. He, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542]. In addition, the 60-100 nm-region emission was recorded. Corresponding emission due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at $E_{D+vib} = p^2 E_{D H_2} \pm \left(\frac{\nu^*}{3}\right) E_{vib H_2 (\nu=0 \rightarrow \nu=1)}$, $\nu^* = 1, 2, 3 \dots$ was observed at the longer wavelengths for $\nu^* = 2$ to $\nu^* = 32$ and at the shorter wavelengths for $\nu^* = 1$ to $\nu^* = 16$ where $E_{D H_2}$ and $E_{vib H_2 (\nu=0 \rightarrow \nu=1)}$ are the experimental bond and vibrational energies of H_2 , respectively. Similar emission due to Ne^+ with hydrogen was also observed, and the exothermic reaction was confirmed using water bath calorimetry. Excess power was observed from the neon-hydrogen plasma compared to control krypton plasma. For example, for an input of 37.7 W, the total plasma power of the neon-hydrogen plasma measured by water bath calorimetry was 60.7 W corresponding to 23.0 W of excess power in 3 cm^3 .

23. R. Mills, J. Sankar, P. Ray, J. He, A. Voigt, B. Dhandapani, "Spectroscopic Characterization of the Atomic Hydrogen Energies and Densities and Carbon Species During Argon-Hydrogen-Methane Plasma CVD Synthesis of Diamond Films", *J. of Materials Research*, submitted.

Polycrystalline diamond films were synthesized on silicon substrates without diamond seeding by low power (80 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of argon-hydrogen-methane (17.5/80/2.5%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that Ar^+ served as a catalyst with atomic hydrogen to form an energetic plasma. CH , C_2 , and C_3 emissions were observed. The argon-hydrogen plasma showed a significantly broadened H Balmer α line. The average hydrogen atom temperature of a argon-hydrogen plasma was measured to be 120-140 eV versus ≈ 3 eV for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

24. R. Mills, P. Ray, B. Dhandapani, W. Good, P. Jansson, M. Nansteel, J. He, A. Voigt, "Spectroscopic and NMR Identification of Novel Hydride Ions in Fractional Quantum Energy States Formed by an Exothermic Reaction of Atomic Hydrogen with Certain Catalysts", *J. Phys. Chem. A*, submitted.

$2K^+$ to $K + K^{2+}$ and K to K^{3+} provide a reaction with a net enthalpy equal to the one and three times the potential energy of atomic hydrogen, respectively. The presence of these gaseous ions or atoms with thermally dissociated hydrogen formed a so-called resonance transfer (rt) plasma having strong VUV emission with a stationary inverted Lyman population. Significant line broadening of the Balmer α , β , and γ lines of 18 eV was observed, compared to 3 eV from a hydrogen microwave plasma. Emission from rt-plasmas occurred even when the electric field applied to the plasma was zero as recorded at Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany). The reaction was exothermic since excess power of $20 \text{ mW} \cdot \text{cm}^{-3}$ was measured by Calvet calorimetry. An energetic catalytic reaction was proposed involving a resonant energy transfer between hydrogen atoms and $2K^+$ or K to form very stable novel hydride ions $H^-(1/p)$ called hydrino hydrides having a fractional principal quantum numbers $p=2$ and $p=4$, respectively. Characteristic emission was observed from K^{2+} and K^{3+} that confirmed the resonant nonradiative energy transfer of 27.2 eV and $3 \cdot 27.2$ eV from atomic hydrogen to $2K^+$ and K , respectively.

The predicted binding energy of $H^-(1/2)$ of 3.0471 eV with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563 \text{ eV}$ (j is an

integer) matched those observed for $j = 1$ to $j = 37$ to within a 1 part per 10^4 . $H^-(1/4)$ was observed spectroscopically at 110 nm corresponding to its predicted binding energy of 11.2 eV . The ^1H MAS NMR spectrum (Spectral Data Services, Inc., Champaign, IL) of novel compound KH^*Cl relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of $p = 4$. A novel NMR (Grace Davison, Columbia, MD and Spectral Data Services, Inc., Champaign, IL) peak of KH^*I at -1.5 ppm relative to TMS corresponding to an absolute resonance shift of -33.0 ppm matched the theoretical prediction of $p = 2$. The predicted catalyst reactions, position of the upfield-shifted NMR peaks, and spectroscopic data for $H^-(1/2)$ and $H^-(1/4)$ were found to be in agreement.

25. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Novel Liquid-Nitrogen-Condensable Molecular Hydrogen Gas", Polish Journal of Chemistry, submitted.

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of $q \cdot 13.6\text{ eV}$ where $q = 1, 2, 3, 4, 6, 7, 8, 9, 11$ or these discrete energies less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of $He(1s^2)$ to $He(1s^1 2p^1)$. These lines matched $H(1/p)$, fractional Rydberg states of atomic hydrogen, formed by a resonant nonradiative energy transfer to He^+ . Corresponding emission due to the reaction $2H(1/2) \rightarrow H_2(1/2)$ with vibronic coupling at $E_{D+vib} = p^2 E_{D_{H_2}} \pm \left(\frac{\nu^*}{3}\right) E_{vib\ H_2(\nu=0 \rightarrow \nu=1)}$, $\nu^* = 1, 2, 3, \dots$ was observed at the longer wavelengths for $\nu^* = 2$ to $\nu^* = 32$ and at the shorter wavelengths for $\nu^* = 1$ to $\nu^* = 16$ where $E_{D_{H_2}}$ and $E_{vib\ H_2(\nu=0 \rightarrow \nu=1)}$ are the experimental bond and vibrational energies of H_2 , respectively. Fractional-principal-quantum-level molecular hydrogen $H_2(1/p)$ gas was isolated by liquefaction using an ultrahigh-vacuum, liquid nitrogen cryotrap and was characterized by gas chromatography (GC), mass spectroscopy (MS), optical emission spectroscopy (OES), and ^1H NMR (Rider University, Lawrenceville NJ) of the condensable gas dissolved in $CDCl_3$. The condensable gas was highly pure hydrogen by GC and MS and had a higher ionization energy than H_2 . An upfield shifted NMR peak was observed at 3.25 ppm compared to that of H_2 at 4.63 ppm . A theoretical rocketry propellant reaction is given that may be transformational.

26. R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Low Power MPCVD of Diamond Films on Silicon Substrates", Journal of Vacuum Science & Technology A, submitted.

Polycrystalline diamond films were synthesized on silicon substrates for the first time without diamond seeding by a very low power (38 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of 10-30% hydrogen, 90-70% helium, and 1-10% CH_4 . The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center

for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada and Material Testing Laboratory, Pennington, NJ), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that He^+ served as a catalyst with atomic hydrogen to form an energetic plasma. The average hydrogen atom temperature was measured to be 180-210 eV versus ≈ 3 eV for pure hydrogen. The electron temperature T_e for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

27. R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Spectroscopic Identification of Lithium Chloro Hydride", Materials Characterization, submitted.

A novel inorganic hydride compound, lithium chloro hydride ($LiHCl$), which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), 1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), and powder X-ray diffraction (IC Laboratories, Amawalk, NY). Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

28. R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Synthesis of HDLC Films from Solid Carbon", Thin Solid Films, submitted.

A novel diamond-like carbon film terminated with $CH(1/p)$ (H^+DLC) comprising high binding energy hydride ions was synthesized from solid carbon by a microwave plasma reaction of a mixture of 10-30% hydrogen and 90-70% helium wherein it is proposed that He^+ served as a catalyst with atomic hydrogen to form the highly stable hydride ions. H^+DLC was identified by time of flight secondary ion mass spectroscopy (ToF-SIMS) and X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA). TOF-SIMS identified the coatings as hydride by the large H^+ peak in the positive spectrum and the dominant H^- in the negative spectrum. The XPS identification of the H content of the CH coatings as hydride ion $H^-(1/10)$ corresponding to a peak at 49 eV has implications that the mechanism of the diamond-like carbon formation involves one or both of selective etching of graphitic carbon and the activation of surface carbon by the hydrogen catalysis product. Thus, a novel H intermediate formed by the plasma catalysis reaction may serve the role of H , oxygen species, CO , or halogen species

used in past systems. Bombardment of the diamond surface by observed, highly energetic species formed by the catalysis reaction may also play a role.

29. R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Characterization of Lithium Chloro Hydride", *Int. J. Hydrogen Energy*, submitted.

A novel inorganic hydride compound lithium chloro hydride, $LiHCl$, which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), 1H nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), and powder X-ray diffraction (IC Laboratories, Amawalk, NY). Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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Upcoming Conference Presentations

50. R. L. Mills, P. Ray, M. Nansteel, J. He, X. Chen, A. Voigt, B. Dhandapani, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source", (Fuel Chemistry Symposium), Am. Chem. Soc. Oral Presentation, 226th ACS National Meeting, (Sept. 7-11, 2003), New York, NY.

Prior Conference Presentations

49. B. Dhandapani, R. Mills, "Novel Liquid-Nitrogen-Condensable Molecular Hydrogen Gas" (Physical

- Chemistry Session) , Wednesday, June 11, 2003, 36th Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
48. P. Ray, R. Mills, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma" (Physical Chemistry Session) , Wednesday, June 11, 2003, 36th Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
47. R. Mills, "Novel Catalytic Reaction Of Hydrogen as a Potential New Energy Source" (Catalysis Session), Tuesday, June 10, 2003, 36th Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
46. J. He, R. Mills, "TOF-SIMS and XPS Studies of Highly Stable Silicon Hydride Films" (Inorganic/Solid State Session), Monday, June 9, 2003, 36th Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
45. B. Dhandapani, R. Mills, "Low Power MPCVD Synthesis and Characterization of Diamond Films on Silicon Substrates" (Inorganic/Solid State Session) , Monday, June 9, 2003, 36th Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
44. X. Chen, R. Mills, "Calorimetric Study of Heat Generation by Catalytic Reaction of Atomic Hydrogen in Resonant Transfer Plasmas" (Fuel Cells Session) , Monday, June 9, 2003, 36th Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
43. R. L. Mills, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Industrial and Engineering Chemistry, "Green Chemistry in the Design of Alternative Energy Strategies", symposium, Oral Presentation, 225th ACS National Meeting, (March 23-27, 2003), New Orleans, LA.
42. R. L. Mills, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source," Monday, November 25, Room 216, Protocol Center, TA-3, Los Alamos National Laboratory.
41. R. L. Mills, "Classical Quantum Mechanics," Monday, November 25, Room 216, Protocol Center, TA-3, Los Alamos National Laboratory.
40. R. L. Mills, Seminar: "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source," US Environmental Protection Agency, National Risk Management Research Laboratory, Sustainable Technologies Division, Cincinnati, OH, October 24, 2002.
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37. P. Ray, R. Mills, "Spectroscopic Characterization of Stationary Inverted Balmer and Lyman Populations

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